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# A Framework and Key Techniques for Supply Chain Integration

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## 1. Introduction

Supply chain integration is a new kind of organizational model, taking dynamic alliance of supply chain as a subject, to realize global resource integration through interactive collaborate operation of supply chain. Different from vertical integration, this integration focuses on the seamless connection of firms to improve the whole supply chain competitiveness by establishing and maintaining a long-term strategic partnership based on information integration, function and business reengineering, organization integration, cultural adaptation and strategic resources reorganization, etc (Chen & Ma, 2006).

Erengue (1999) brought forward four valuable research fields of supply chain, among them 3 are relevant to supply chain integration, i.e. integrated approaches to managing inventory decisions at all stages of the supply chain, the use of information sharing in a multi-partner supply chain, and analytical and simulation models that integrate the three major stages of supply chains which he thought to be is an important future direction of research in the area of supply chain. The literature suggests different theoretical models to describe and operationalise integration. Hammel & Kopczak (1993) pointed out that supply chain life cycle is a whole process from the construction to disaggregation of supply chain and defined the processes of construction, operation and disaggregation from the perspective of focal firm. Fisher (1997) and Nissen (2001) investigated supply chain integration from the aspect of product and agent-based separately. More recently, Lalwani & Mason (2004) and Mason & Lalwani (2006) use a model to characterize the extent of integration in relation to TPL providers. Tang & Qian (2008) established a PLM framework to enable supplier integration and partnership management in the automotive development process.

In connection with a survey of the relation between supply chain collaboration and logistics service performance (Stank et al., 2001), a framework for establishing the degree of internal and external collaboration is set up. This framework is further developed by Gimenez & Ventura (2005) in order to study internal and external integration as well as the influence of integration on performance. Again, the framework is appealing, but does not include a more systematic and detailed description of the specific tasks and processes involved in the

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cooperation. An operationalisation of the integration concept requires the identification of both the most essential tasks to be solved in connection with supply chain management and the underlying activities to be carried out to accomplish these tasks (Mortensen et al, 2008).

In this paper, investigating the methods of supply chain integration for manufacturing industry in the background of China, a three-echelon theoretical framework for supply chain integration based on Thorn's model (Thorn, 2002) is established. And then the relative techniques are presented in each level, which will be illustrated as following.

## 2. The three-echelon theoretical framework for supply chain integration

In order to integrate supply chain effectively, based on the comprehensive hierarchical planning framework by Thorn, we establish a theoretical framework for supply chain integration. According to the framework, the key relative techniques can be sorted into three echelons based on the rules from entity objectives to relative objectives and from basic capabilities to advanced capabilities- the basic operations management level, the planning and controlling level and the strategic management level.

*The integration in operations management level.* The supply chain operations level involves the whole process from the material acquisition to order fulfillment, which is the physical level and basic elements of supply chain. The supply chain integration must begin with the integration of this level, which is the basis of collaboration between all the firms.

According to the organizations and the functions, the integration in the operational management level includes internal integration of the focal manufacturer, the supplier integration, the distributor integration and the customer integration.

*The integration in planning and controlling level.* The excellent operation needs the support of integrated planning and performance evaluation, which involves the utilization of multiply techniques to plan, control, assess and improve performance. The integration in planning and controlling level coordinates all the business processes, esp. source, make, order fulfillment and inventory replenishment by information utilization and coordination. The core competencies in this level involve: databases, which enable the members to share necessary information; transaction system, which can initiate and deal with inventory replenishment and customer order fulfillment. Besides, it is vital to form the capability relevant to internal communication and collaborative operation. IT-based CPFR strategy is helpful to forming the core competencies. Meanwhile, it is also vital to monitor the business process through performance evaluation and improve the integrated performance continuously. Therefore, the key elements in planning and controlling level can be summed up as IT-based CPFR strategy and performance evaluation.

*The integration in strategic management level.* Out of question, successful supply chain integration needs partnership and management skills to maintain the partnership, while the skills always come from unique organization culture which is the basis of partner selection and maintaining. Thereby partnership maintaining and cultural adaptation are the two kernel elements in strategic management level.

Fig. 1 shows the framework and the key elements in every level for supply chain integration. On the basis of core competencies are integrated well with support capacities, the focal firm can coordinate four kinds of flows- product/service flow, knowledge flow, information flow and fund flow – to produce value.

*The product/service flow* refers to the serials of value-adding activities of product/service from material acquisition to end customers. The values add to the product when the product

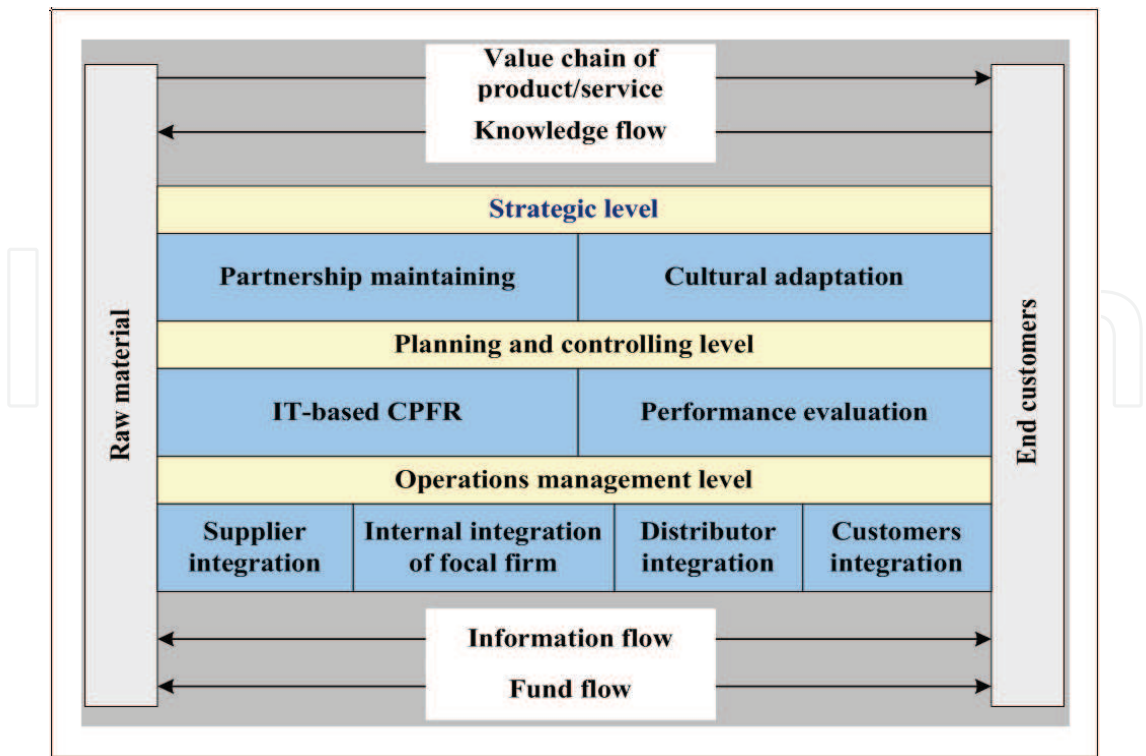


Fig. 1. The three-echelon theoretical framework for supply chain integration

flows along the supply chain and experiences physical changes, packaging, launch, customization, service support and other relative activities until meet the needs of end customers.

*The knowledge flow* is a reverse flow from end customers to suppliers. It always involves the exchange information about sales mode and product description, such as the customization requests, POS data, consumption information of end customers, warehouse and shipment information, etc. The information is vital to supply chain planning because it is helpful for the members to know the sales status well and then reach consistent understanding on customer requirements and consumption status. On the basis, better plans are formulated and the supply chain can work collaboratively.

*The Information flow* is a kind of inter-communicational flow between supply chain members. The information always includes forecast information, promotional plan, purchase order, order confirmation, shipment and inventory information, invoice, payment and replenishing requirements, etc. The information exchange can trigger, control and record the flow of product/service. With the ICT development, more and more information are exchanged by EDI and network instead of paperwork.

*The fund flow* always moves against the value-adding activities. Capital turnover and return on assets are the two main financial metrics which are of great importance to the supply chain performance.

The four flows exist always even if no coordination in the supply chain. However, under the circumstance of low integration and bad coordination, the flows move unsmooth which will result in delay, redundancy and inefficiency. While, integrated supply chain will accelerate the flows, with which the supply chain can produce maximum customer value and keep in a good condition meanwhile.

3. Key elements in the operational management level

The operation management level is the level aiming at synchronous operation of supply chain. The key issue in this level is how to balance and coordinate the restrictions, such as resources, information, capacity and time, through integration and coordination within each firm and between firms. The integration in operations level of supply chain can be illustrated in two dimensions: internal integration and external collaboration, shown in Figure 2. In the following, we will illuminate them and the key elements separately.

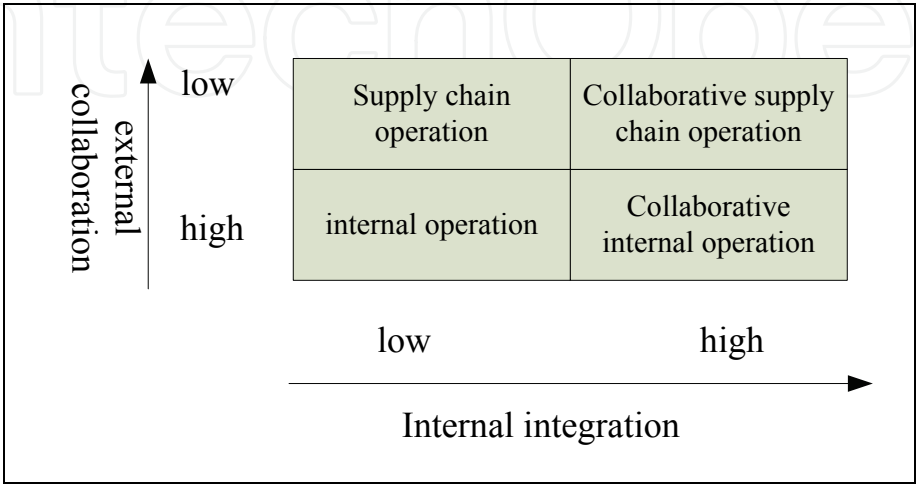


Fig. 2. The operational integration matrix

3.1 Internal integration and collaborative internal operation of within focal firm

The internal integration, the function to function integration within the focal firm, is the first step of operations integration, and also the basis of to success of supply chain integration. High internal integration can reach a level of “collaborative internal operation”, with which the whole firm works like an integrated system that results in better performance and better interdepartmental effectiveness, such as cycle time reduction, better in-stock performance, increased product availability levels, and improvement in order-to delivery lead times (Harrison et al, 2008). Moreover, high internal integration is also the foundation of high external integration. A study of Spanish food manufacturers by Gimenez (2006) shows that the highest levels of external integration are achieved by firms which have already achieved the highest levels of internal integration between logistics, production and marketing.

For the internal integration is process-oriented, the firms need to come across the border of functions to build a borderless flat organization through BPR (business process reengineering) combined with ICT-based advanced production modes, such as MRPII (manufacturing resources planning), ERP (enterprise resources planning), lean production, agile manufacturing, concurrent engineering, etc.

BPR is the fundamental approach for internal integration within the focal firm, which emphasizes ‘... the fundamental rethinking and radical redesign of business processes to achieve dramatic improvements in critical contemporary measures of performance, such as cost, quality, service, and speed.’ To implement BRP effectively, Hammer (1990) presents seven principles for BPR: organize around outcomes, not tasks; have those who use the output of the process perform the process; subsume information-processing work into the real work that produces the information; treat geographically dispersed resources as though



they were centralize; link parallel activities instead of integrating their results; put the decision point where the work is performed, and build control into the process; capture the information once and at the source.

Base on these principles, cross-functional team, first presented by Toyota in lean production, can be one of the rational reference models for internal integration. While before the actual efforts of new model, the firms should define some mechanisms and actions to monitor and evaluate the status of collaboration, and then improve the initiative planning process. ‘Alignment Compass’ (van Hoek & Mitchell, 2006), the alignment analysis tool shown as Figure 3, illustrates four areas where alignment improvement efforts could be focused: in the interactions with peers from other functions, in interactions with their bosses and the Board, in interactions with their teams, and in their own day-to-day behavior.

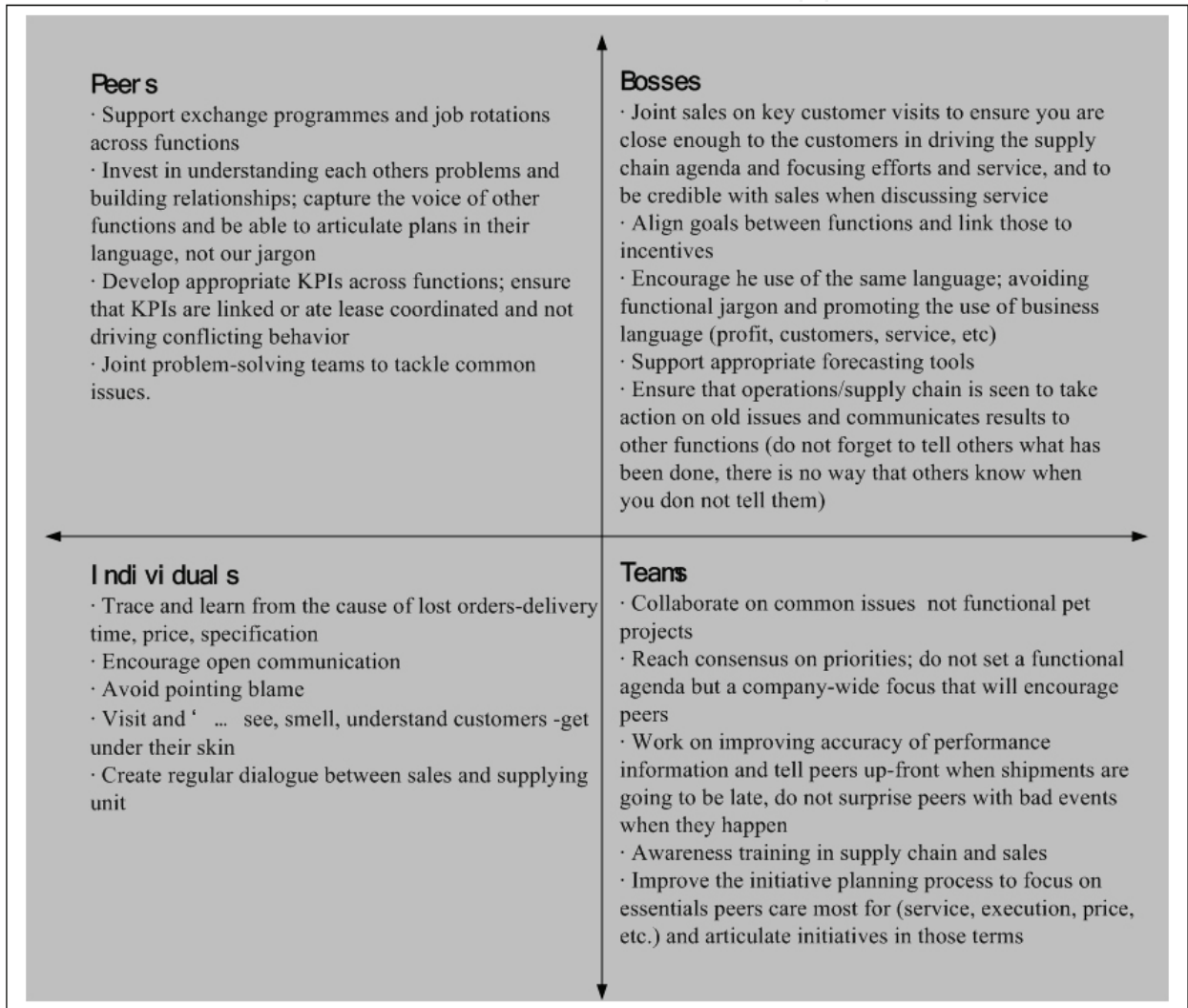


Fig. 3. Alfa Laval’s alignment compass (van Hoek and Mitchell, 2006)

When the focal firm finished internal integration, it must follow some rules as below to carry out the new business model successfully:

*Rule 1 Transfer from functional management to process management.* The new model is process-oriented, and put the decision point where the work is performed, therefore response to market and customer will be improved through the shortened communication channel and time.

*Rule 2 Focus on systematic philosophy about whole process optimization.* Reengineer and optimize the business process to delete the useless activities or non-value-added activities, meanwhile, make each activity add the maximum value to customers. Note that all of these are base on global optimization, not local optimization, aiming at eliminating the selfish departmentalism and advantages equalitarianism.

*Rule 3 Build a flat organization.* Design processes first, and then build the organization based on processes. Remove the middle-level managers as could as possible.

*Rule 4 Have everybody play his important role in the whole business process.* Each person who processes the business should have comprehensive qualification and teamwork spirit. At the same time, the organization should build a new mechanism for self-learning.

*Rule 5 Integrate business processes oriented to customers and suppliers.* In the age of competition between supply chains, the firm should consider not only the collaboration between internal business processes, but the redesign of the interfaces between the focal firm with its customers and suppliers, when implementing BPR.

*Rule 6 Resolve the conflicts between dispersed business and centralized management using ICT.* When designing and improving the business processes, the firm should make the most use of ICT to process and share information as far as possible, convert sequencing processes into synchronous ones, resolve the conflicts between separated businesses with centralized management.

All in all, the firm can provide the right products with lowest costs and accurate amounts at right time and right place through BPR and integration of internal core businesses. Furthermore, high internal integration will improve the firm's decision-making capability dramatically, so the firm can capture the opportunities and win the competition in the fierce market.

### **3.2 External collaboration and collaborative supply chain operation**

The second dimension of operational integration is called external integration, or inter company integration, referring to the cross-border operational integration in the supply chain which can place customer and supplier processes closer together. Compared with internal integration, external integration is a relative new concept, which integrates a firm's logistics with external logistics of suppliers and customers by the excellent collaboration between the partners. High external integration has some features like: increased logistics transactions with suppliers and customers; increased logistics collaboration between the focal firm with their customers and suppliers; more indistinct organizational boundary between partners in logistics collaboration. External integration makes the supply chain operate like a real physical entity to gain more powerful competitive advantage.

High external integration can be divided into 'supply chain operation' and 'collaborative supply chain operation' based on the internal integration level of each firms. The former one is high external integration with low internal external integration (In fact, it rarely exists). The latter one is a real high integration type base on high internal integration and high external integration. High-integration supply chain operates in a form of virtual organization, which is like a physical entity with high competency.

External integration can be divided into three basic types according to the partner along the material flow - supplier integration, distributor integration and customer integration, which will be explained in detail as following.

### 3.2.1 Supplier integration

Supplier integration plays a very important role in the operational integration of supply chain. One of the keys to increased responsiveness in the supply chain is a high-integration with upstream suppliers. Therefore the focal firm should pay more attentions on supplier development and integration to build partnership with the suppliers, which can increase the firm's performance or capabilities and meet short-term or long-term supply needs of buyers. Based on PDCA (Plan-do-check-action) cycle, we build a model- supplier integration cycle to support the activity of supplier integration. The model can be divided into 5 stages around with the goal of supplier development and excellent performance. At the initial stage, the firm should set up clearly and consistent objectives, which must communicate with the suppliers carefully. At the second stage, the firm should select qualified suppliers and establish a perfect evaluation system and assess the supplier performance based on the evaluation system. At the third stage, feed back the actual performance to the suppliers. While at the fourth state, the suppliers analyze the process to find the performance gap, and then formulate plans to improve their performance. Finally, the focal firm admits suppliers' performance and gives them the relative treatments according to their performance to support joint development. The supplier integration cycle is shown as Figure 4. In the following we will illustrate how the cycle operates based on John Deere's practices.

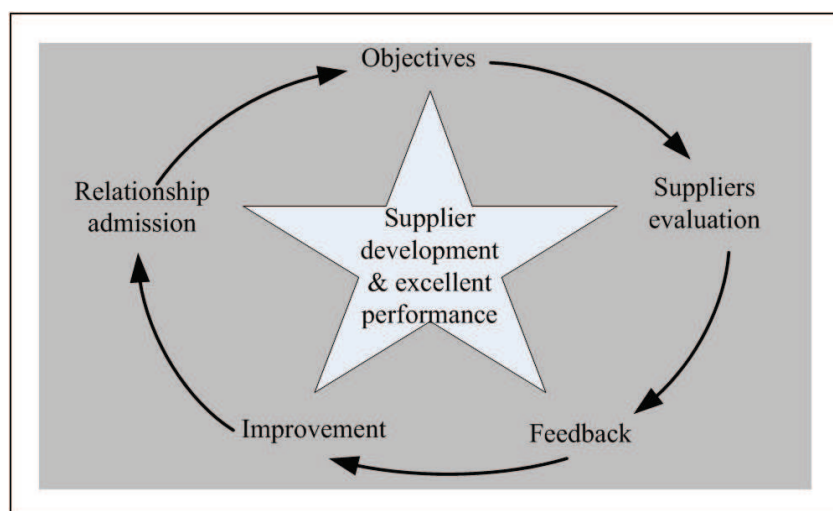


Fig. 4. The supplier integration cycle

*A. Objective setting.* The first step of supplier integration is to set the consistent objectives and strategies, on the basis, integrate information, processes and resources to realize quick response to customer needs. The objectives of supplier integration always involve:

- Build a win-win relationship with supplier, share the resources each other, and achieve continuous improvement (CI) to win the competitive advantage in the marketplace.
- Control the total cost by quality improvement combined with cost management.
- Build effective performance measurement system to lead and encourage CI, and communicate with suppliers on their performance timely and accurately. Meanwhile, provide standards of supplier admission for their excellent performance. On the basis, carry out strategic sourcing.
- Encourage the suppliers to involve in all the core processes and make full use of their technical supports, innovations and experiences to improve the capability and competitiveness of the whole chain.



*B. Supplier evaluation.* Often, the suppliers need to be evaluated from such aspects as quality, delivery, cost, technical support and collaboration, to determine their relationship with the focal firm. The contents of these metrics are illustrated as below.

- *Quality*, the metrics on the capability that suppliers' quality management system and material provided meet the requirements, expectation and material quality of the focal firm. This metrics, involving quality PPM and quality effects, provides suppliers with the statistical information on their products/service quality.
- *Delivery*. Delivery evaluation provides the statistical basis for suppliers with their order fulfilling capability based on order amounts and delivery date. The delivery level is denoted by PPM (Delivery PPM = number of defects/supplied amount $\times 10^6$ ), which is calculated based on the amounts of early delivery, late delivery or over delivery.
- *Technical support*, the metrics on suppliers' knowledge and their capability of technology application, to determine whether they can support strongly the focal firm's needs of product development and manufacturing. The performances of suppliers in such fields as the product techniques and innovations, the delivery process, the manufacturing process, the time of manufacturing critical path, and the warranty are involved in the evaluation system.
- *Collaboration*, comprehensive analysis of suppliers' initiative, attitude, responsiveness, communication, detail-concerned, and safety performance. The evaluation fields always include information share, problem-solving, responsiveness to customer requirements, business relations, consistency of processes, and the quality and smoothness of electric commercial.
- *Cost*, the metrics on the capabilities of supplier in price competitiveness, cost control and reduction. The evaluation objects include the cost reduction planning, the net cost reduction performance, the enthusiasm in cost control and the performance during product delivery.

As for the collaborative relationship, according to the supplier performances, it can be divided into four grades as following.

- *Partners*, the suppliers whose performances have topped the performance measurements of the focal firm and reach the world class level, and played an important role to customers satisfaction of the focal firm.
- *Key suppliers*, the suppliers whose performance have topped the lowest level of the focal firm and are go further towards the world class level continuous.
- *Qualified suppliers*, the suppliers whose performances reach the lowest level of the focal firm, but no action on continuous improvement.
- *In questioned suppliers*, the suppliers whose performances are lower than the lowest level of the focal firm and may be rejected from the supplier group.

The final level is determined by the lowest one of any field and the supplier performance in each field is assessed by cross-functional team. The evaluation system is shown in Table 1.

*C. Feedback and improvement.* After evaluation, the focal firm will give the suppliers feedback on their performances. Besides the information of past and current performances, the status of other key suppliers is also presented in the report to encourage the supplier's improvement. Moreover, it is prescribed that the suppliers those achieve a 50% improvement in some field (quality, delivery, etc) than the early year can be upgraded to the upper one level (e.g. from qualified supplier to key supplier, but never from key supplier to partner). It is a measure to encourage the CI activities of suppliers.

	Partner 92%-100%	Key supplier 80%-91%	Qualified supplier 70%-79%	In questioned <70%
Quality	Excellent quality, topped in all metrics; high reliable product/service; well-recorded and filed quality plan & improvement measures; excellent outcomes in continuous improvement	Excellent quality plan; timely response to quality problems; reliable product/service; better outcomes than measurements consistently	Quality meets the expectation; passive response to quality problems; substantially satisfied by inner customer; approved but not implemented collaboration agreement	Ordinary service; inadequate product quality; may not keep the business relations with this supplier.
Delivery	Always deliver product/service on-time; actively respond to the short-time order; seamless link of delivery process to pricing process.	Can deliver product/service on-time and respond to the short-time order; a few pricing problems.	Always be reminded of product/service delivery; sometimes need to be followed on the problems of delivery and/or price; respond passively with no expectation	Need to be traced; always failed to due date; very long lead time; and no measures are taken to shorten lead time.
Technical support	Respond to technical problems and service problems promptly; explore and implement innovation in techniques; provide advanced techniques for customers; service representatives are fully-trained and are the expert of their field.	Rarely go wrong when introduce new or existing product/service; service representatives are able to solve most techniques or service problems; make efforts to implement innovation in techniques under proper directions.	Reply to technical change passively (not actively); sometimes new products or new services are unusable; need to be followed to implement innovation in technique sufficient technical support.	No technical support; and no response to changes.
Collaboration	Care for customers' experiences; make great efforts to continuous improvement actively; provide accurate information over expectation; be good at teamwork and communication; clear, open and frank business relations	Support its staff and worker fully; outcome-oriented to meet the expectations all the time; com in on problem-solving actively.	Need to be traced; respond to customers requirements passively with no prediction; share information sufficiently	Difficult to file and share information; low reliability; need to clarify and trace the information all the time.
Cost	Have set goals of continuous cost reduction and monitor its operations; focus on inner cost, make great efforts to reduce the cost both internally and externally with suppliers; keep the most competitive price always.	Make efforts to reduce cost and gain some opportunities internally and external internal from suppliers; the price is competitive	Make few efforts to control cost control; need to be encouraged to implement cost reduction activities.	No cost reduction action; uncompetitive price

Table 1. Supplier evaluation system

*D. Relationship admission.* Supplier relationship admission refers to the plans and activities of supplier development after determining the supplier relationships by evaluation, feedback

and improvement. According to the different relationship, different development plans are formulated. For instance, the partners can be involved in the new product design and bid for other businesses. Besides, they can join the training plans, attend the meetings of supplier management, and so on. The key suppliers are also qualified to join the training plans and the meetings of supply management. But they are just considered to be involved in the business processes of new product design and new business development. As for qualified suppliers, they are qualified to some specific training plans, and may be invited to participate in the meeting of supply management, and also have the possibility to be thought of involving in the business processes of new product design or new business development. However, the suppliers in questioned are not admitted at all.

The relationship admission can enhanced the relationship between focal firm and its suppliers to upgrade the supplier integration level step by step.

### 3.2.2 Distributor integration

The downstream of the focal firm is the distributors. It has been suggested for a long time that manufacturers, esp. those produce industrial product, should treat their distributors as partners (Narus et al, 1986), which means that the manufacturers should admire the value of distributors and provide necessary support to the distributors to win the competition in marketplace. In fact, the distributors always possess lots of information about the customer requirements, which the manufacturers will need when they want to develop new products and production line successfully. Moreover, integrating with the distributors can share the skills between the distributors to meet the end customers' needs much better.

The distributor integration can be realized mainly in two aspects.

First is sharing inventories within the alliance of the focal firm and all the distributors to protect the downtime from emergency orders. Traditional distributor management fulfilled the emergency orders by increased inventory. On the contrary, distributor integration can decrease the inventory by sharing inventory information between all the distributors. Every distributor can check others' inventory records to determine its own. And in some cases, distributors have the contract-type duty to exchange parts at a consentaneous price. Sure, it needs the support of advanced information system.

Second is to improve each distributor's capacity in explicit skills and capability of response to non-routine requirements. In this type of alliance, different distributors can cultivate their skills in different fields. And a specific customer requirement can be inducted to the most skillful distributor. Otr is a good example of this skills integration and collaboration.

There are two issues which need to be paid much attention in distributor integration. First, the distributors may doubt about their returns of taking part in such a system. They will feel upset when they think of they are providing some inventory control skills to their inexperience partners, esp. when some distributors are more powerful and holding more inventory. Second, some distributors have to rely on other distributors to help them improve the customer service. However, sometimes the distributors who are relied on may not know what will happen. Third, the new type of collaboration will easily lead to a status that a certain responsibilities and skills may be transferred from some distributors to a certain new distributors, which upsets some distributors. All these problems illuminate that distributor integration is a very difficult task in SCI which need the focal firm to devote lots of resources and efforts to get the trust of its distributors (Simchi-Levi et al, 2003)

### 3.2.3 Customer integration

Ken Burnett (2002) pointed out that the capability of identifying, understanding and meeting the needs of important customers can always be seen from most of successful companies. Developing a long-term partnership with these important customers is key to successful customer integration. Only if the partnership can be maintained well, can a firm realize lean and integrate with the customers. The process of partnership development and customer integration is shown as below (Zhou, 2006):

*Step 1 Requirements analysis.* In this more and more stinging market, the company must perceive the rapid change of customers needs (not only the explicit requirements, but also the tacit requirements), and give quick responses to them. In order to reach the target, the company should understand them from multiple perspectives – industrial perspective, dynamic perspective and purchase perspective, to determine its targeted customers based on mutual complement, compatibility and win-win premise, and then attract the customers depending on its business strengths.

*Step 2 Value positioning.* Value positioning is the kernel of customer partnership. Whether a company can establish long-term customer relationship depends more on its capability of creating durative customer value. Value identification, value selection and value supply compose the value creation process. Identifying the factors of affecting customer value judgment, finding the features the customer most concerned, and thinking over the value positioning of competitors combining with its own advantages, will help the company to find new breaks of value innovation. Then the company can configure the resources based on the new breaks and the total product concept as well to provide conceived value for customers and then to realize value position.

*Step 3 Strategies matching.* It means that the strategic orientation, competitive strategy and strategic resources input to the focal firm must match its customers' needs to enhance the collaboration. Based on the analysis of the enterprise environment and its own resources, the focal firm should formulate its strategy aligning with the selected value position and matching it to its partners.

*Step 4 Process improvements.* The focal firm should transfer its main business process into strategic capability to provide valuable service to customers. That means the firm should enhance its core business process and make it un-imitable to customer.

*Step 5 Partnership maintenance.* In order to make full use of customer partnership, the company must deal with the relationship carefully, including effective innovation and strict risk control. Rational partnership innovation combined with effectual control is key elements to customer partnership success.

## 4. Key techniques in planning and controlling level

### 4.1 IT-based CPFR strategy

Information plays a very important role in the operational process of supply chain. Low level of information transparency and visibility will result in the unnecessary 'transit' cost. While the CPFR strategy based on more active information sharing mechanism and more effective inventory forecasting and replenishing measures will ensure a more smooth supply chain. In this section, we will provide a practical method to realize CPFR by forecasting demand with time series analysis and the adoption of a Push/Pull integrated inventory management system.



#### 4.1.1 Supply chain visibility and bullwhip effect

Supply chain visibility was defined as 'the ability to see clearly from one end of the supply chain to another and, in particular, to share information on supply and demand issues across corporate boundaries' (Christopher & Gattorna, 2005). Lack of visibility will cause the uncertainty of demand and the most obvious phenomenon led by uncertainty is the bullwhip effect. When a supplier from a certain level makes decision only based on the demand of its next distributor, the data distortion will move upstream along the supply chain therefore intensify level by level. As a result, when reaching the headstream supplier, the accumulated distortion will vary the demand quite a lot from the real condition of the ultimate market (Zhang et al, 2003). Figure 5 shows typical order patterns faced by each node in a supply chain that consists of a manufacturer, a distributor, a wholesaler and a retailer. The retailer's orders to the wholesaler display greater variability than the end-consumer sales; the wholesaler's orders to the manufacturer show even more oscillations; and, finally, the manufacturer's orders to its supplier are the most volatile. Even a slight change in consumer sales ripples backward in the form of magnified oscillations upstream, resembling the result of a flick of a bullwhip handle.

#### 4.1.2 CPFR-base logistics and supply chain management

To decrease the bullwhip effect and enhance supply chain visibility, there is a growing recognition of the importance of shared information within the supply chain. For example, the adoption of 'Collaborative Planning Forecasting and Replenishment' (CPFR) is beginning to make a difference. CPFR involves the joint determination of forecasts through pooled knowledge and information. Based on this agreed view of demand over the forecast horizon, the supplier takes responsibility for the replenishment of supplies based upon the actual rate of sale or usage (Ireland, 2000). The realization of CPFR requires the establishment of an information-sharing platform, which pools the information of customer demand, order adjustment, transportation plans etc., among manufacturer, distributor, wholesaler and retailer. In this way, the visibility of supply chain could be enhanced whilst suppliers and distributors could clearly know the sales volume and the products inventory at the retail store, distribution center and manufacturing sites, so that they can better forecast the demand.

##### A. Demand Forecast by Time Series Analysis

The first step to realize CPFR is to accurately forecast demand in the future. Therefore, a time series analysis could be a practical method.

*Hypothesis 1* Influence factors of demand. A time series can be defined as chronologically ordered data that may contain several components of demand: trend, seasonal, cyclical, autocorrelation and random. In practice, it is relatively easy to identify the trend and the seasonal component, but more difficult to identify the cycles, autocorrelation and random components. We hypothesize that demand contains both seasonal and trend effects in here.

*Hypothesis 2* The type of demand variation: multiplicative seasonal variation. The multiplicative seasonal variation is the usual experience. Figure 6 shows the seasonal variation increasing as the trend increases because its size depends on the trend. Forecast including trend and seasonal= Trend  $\times$  Seasonal factor.

*Hypothesis 3* Seasonal Factor. A seasonal factor is the amount of correction needed in a time series to adjust for the season of the year.

Align with these hypothesizes, we take A firm as an example to explain how to forecast demand of the future. A firm's sales for a product line during the 12 quarters of the past



three years were as follows (Table 2). Our objective is to forecast demand for the four quarters of the fourth year using Least Squares Regression to analyze the Time Series.

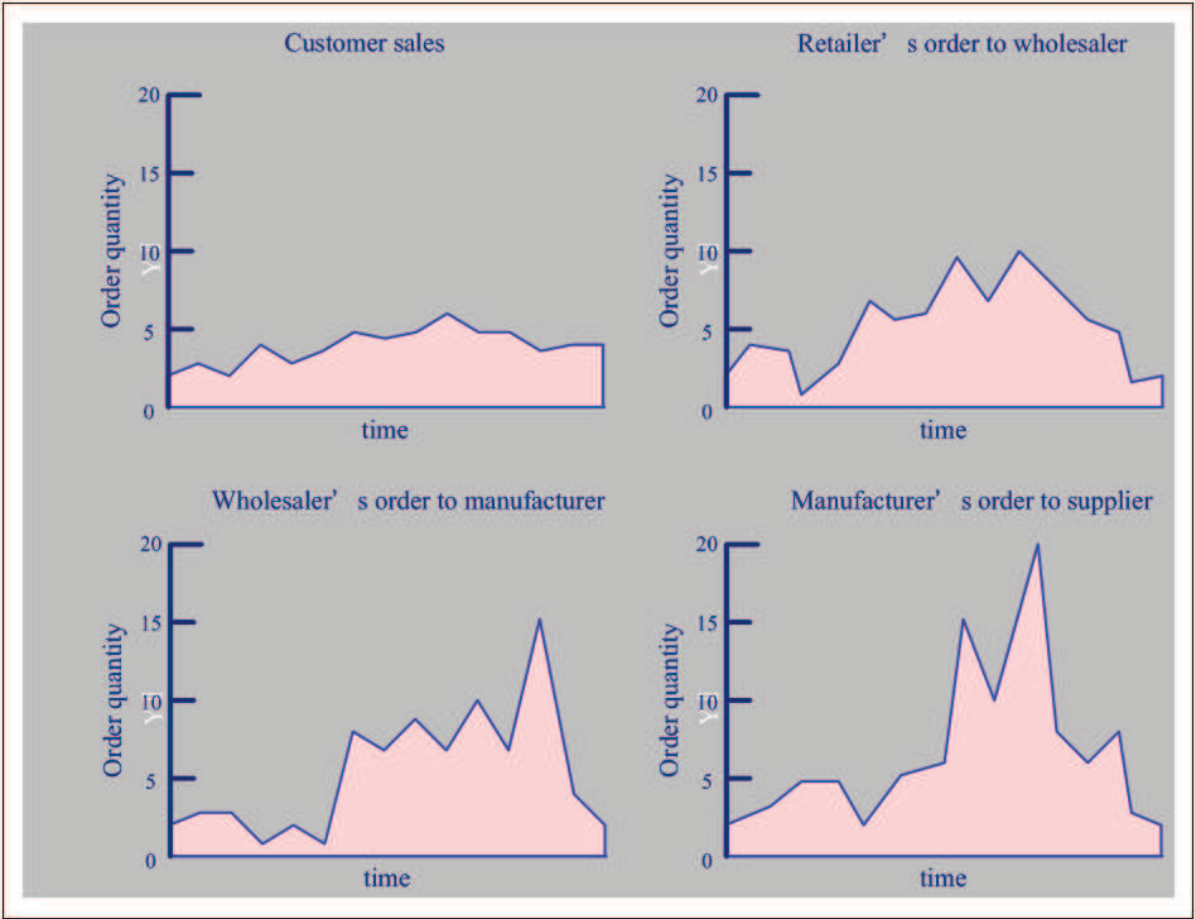


Fig. 5. Increasing variability of orders up the supply chain

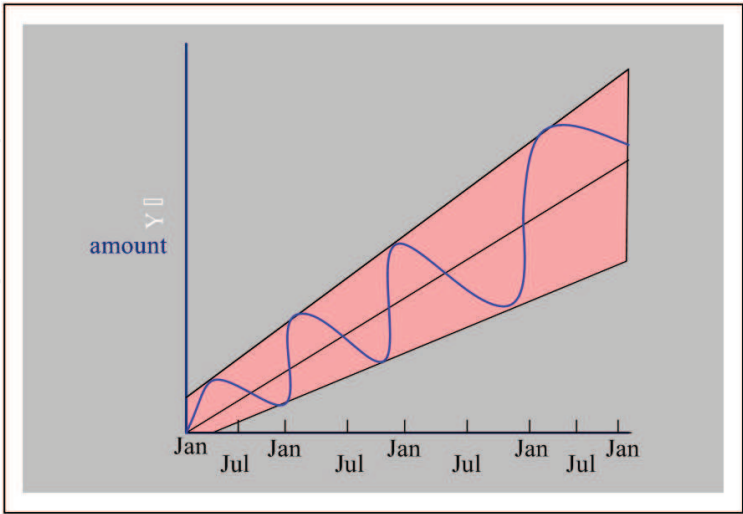


Fig. 6. Multiplicative Seasonal

*Step 1. Determine the seasonal factor.* Table II summarizes the calculations needed. Column 4 develops an average for the same quarters in the three-year period. For example, the first quarters of the three years are added together and divided by three. A seasonal factor is

then derived by dividing that average by general average for all 12 quarters (33,350/12 or 2,779.1667). These are entered in column 5. The seasonal factors are identical for similar quarters in each year.

Qtr	sales	Qtr	sales
1	600	7	2600
2	1550	8	2900
3	1500	9	3800
4	1500	10	4500
5	2400	11	4000
6	3100	12	4900

Table 2. A firm’s sales during the past three years

Step 2. Deseasonalize the original data. To remove the seasonal effect on the data, we divide the original data by the seasonal factor. The result is shown in column 6 of Table 3.

(1) Prd (x)	(2) Qtr	(3) Actual Demand (y)	(4) Average of the Same Quarters of Each Year	(5) Seasonal Factor	(6) Deseasonalized Demand(y <sub>d</sub> ) Col.(3) ÷ Col.(5)	(7) x <sup>2</sup> Col.(1) <sup>2</sup>	(8) x×y <sub>d</sub> Col.(1) ×Col.(6)
1	I	600	(600+2,400+3,800)/3 =2,266.7	0.82	735.7	1	735.7
2	II	1,550	(1,550+3,100+4,500)/3 =2,700	1.10	1,4122.4	4	2,824.7
3	III	1,500	(1,500+2,900+4,900)/3 =3,100	0.97	1,544.0	9	4,631.9
4	IV	1,500		1.12	1,344.8	16	5,379.0
5	I	2,400		0.82	2,942.6	25	14,713.2
6	II	3,100		1.10	2,824.7	36	16,948.4
7	III	2,600		0.97	2,676.2	49	18,733.6
8	IV	2,900		1.12	2,599.9	64	20,798.9
9	I	3,800		0.82	4,659.2	81	41,932.7
10	II	4,500		1.10	4,100.4	100	41,004.1
11	III	4,000		0.97	4,117.3	121	45,290.1
12	IV	4900		1.12	4,392.9	144	52,714.5
78		33,350		12.03	33,350.1	650	265,706.9
<div><div><math display="block">\bar{x} = \frac{78}{12} = 6.5</math></div><div><math display="block">b = \frac{\sum xy_d - n\bar{x}\bar{y}_d}{\sum x^2 - n\bar{x}^2} = \frac{265,706.9 - 12(6.5)2,779.2}{650 - 12(6.5)^2} = 342.2</math></div><div><math display="block">\bar{y}_d = 33,350 / 12 = 2,779.2 \quad a = \bar{y}_d - b\bar{x} = 2,779.2 - 342.2(6.5) = 554.9</math></div><div>Therefore, <math>Y = a + bx = 554.9 + 342.2x</math></div></div>							

Table 3. Deseasonalized demand

Step 3. Develop a least squares regression line for the deseasonalized data. The purpose here is to develop an equation for the trend line Y, which we then modify with the seasonal factor. The least squares equation for linear regression:

$$Y = a + bx$$

(1)

Where,

$Y_d$  = Deseasonalized demand (See Table 3)

x= Quarter

Y= Demand computed using the regression equation (1)

a = Y intercept

b= Slope of the line

The least squares calculations using columns 1, 7, and 8 of Table II are shown in the lower section of the table. The final deseasonalized equation for our data is  $Y = 554.9 + 342.2x$ .

Step 4. Project the regression line through the period to be forecast. Our purpose is to forecast periods 13 through 16. We start by solving the equation for Y at each of these periods (shown in Table III, column 3)

Prd	Qtr	Y from regression line	seasonal factor	forecast (Y×seasonal factor)
13	1	5,003.5	0.82	4,102.87
14	2	5,345.7	1.10	5,880.27
15	3	5,687.9	0.97	5,517.26
16	4	6,030.1	1.12	6,753.71

Table 4. Final forecast adjusted by the seasonal factor

Step 5. Create the final forecast by adjusting the regression line by the seasonal factor. Multiply the quarterly data we derived by the seasonal factor for that quarter and we can get the final forecast (shown in Table 4, column 5).

B. Push/Pull Integrated Inventory Management System

The second step to realize CPFR is to replenish inventory quickly and reasonably. According to compacting multistage response management mode, not only does an organization have to turn out the right amount of products, but also has to response quickly to the market. It is not enough to fulfill the management demand when we use push or pull operational system singly. So a push and pull integrated inventory management system is brought out.

The upstream companies will carry out processes of purchase, manufacture and replenishment according to the Push Operational System, which basically belong to the mode of make to stock (MTS). They can also use the forecast method we mentioned above to determine the production lot sizes, stock level and reorder point based on the history orders of the downstream companies. The key point of the upstream operational process is JIT supply - to fulfill the downstream companies' producing demand while making them kept a low inventory level.

The downstream companies will carry out processes according to the Pull Operational System, which basically belong to the mode of make to order (MTO). They make the decision of orders to the upstream companies based on the history orders of their customer. The key point of the downstream operational process is quick response (QR), which means to perfectly fulfill the customer's purchasing demand through close cooperation in accelerating the logistics flow between retailer and supplier.

Push/Pull integrated operational system requires the upstream to prepare the spare parts aptly for the downstream or to finish the assembly to a certain degree, so that the downstream can accomplish the final process of assembly quickly when the customer’s order arrived. The companies in both upstream and downstream have to build a quick response network which integrates each other’s needs and techniques. In this way, more efficient logistics and information flows can be adopted, which ensure a better realization of the shared goal to provide higher quality product in shorter time. Push/Pull will realize economies of scale in the upstream of supply chain whilst satisfy the customization needs in the downstream.

4.2 Performance evaluation

Performance evaluation is the basis of supply chain management. SCOR (Supply Chain Operational Reference) model (SCC, 2008), which is founded on five distinct management processes and viewed in terms of overlapping management processes – source, make, deliver and return – within an integrated framework that encompasses all of the organizations in the chain, provides a good method to assess the supply chain performance, a process-based method of supply chain evaluation. From the model, the firm can obtain the benchmarking data and judge their internal operational performance.

There are three levels to the SCOR model: Level 1 defines the scope and content for the Supply Chain Operations Reference-model. Here basis of competition performance targets are set. Level 2 configures a company’s supply chain from core “process categories” (e.g., make to order, make to stock). Level 3 defines a company’s ability to compete successfully in its chosen markets. Detailed performance metrics are set in this level.

Table 5 shows 10 metrics at level 1 in SCOR model, which is taken from the SCOR website. Then the model provides a breakdown of level 2 and level 3 subcomponents of level 1 metrics to identify the opportunities of improvement. An individual company should not attempt to be “best in class” in all areas. Rather, a given company should targets its strength I four to six selected areas to create differentiation in the marketplace, and ensure that it stays competitive in the other areas. The Supply Chain Council also gives the benchmarking information for participating companies.

Level 1 Metrics	Performance Attributes				
	Customer-Facing			Internal-Facing	
	Reliability	Responsiveness	Agility	Cost	Assets
Perfect Order Fulfillment	√				
Order Fulfillment Cycle time		√			
Upside Supply Chain Flexibility			√		
Upside Supply Chain Adaptability			√		
Downside Supply Chain Adaptability			√		
Supply Chain Management Cost				√	
Cost of Goods Sold				√	
Cash-to-Cash Cycle Time					√
Return on Supply Chain Fixed Assets					√
Return on Working Capital					√

Table 5. Supply chain performance and the measurements that can be benchmarked

A company must measure and then enhance its capability of planning, sourcing, making and delivering illustrated in level 2 and level 3 (shown as Table 6), to meet the needs of customers. The degree of these metrics reach will determine its operational competency. Order and order fulfillment by XX, JIT delivery, inventory turnover, and cash-to-cash cycle time are the most important metrics of operational measurement. Some activities are linked to the metrics, e.g. the inventory management will affects the fulfillments of order and order by XX highly. So the company should collect and evaluate all the four processes operational information to make decisions. If it was found that the operations have some biases with the targeted performance, the company should investigate the relative businesses processes from the three types attributes shown as level 3, which are also called level 3 consultant metrics. Table 6 shows that the consultant metrics can be used not only to analyze the complexity and structure of supply chain, but to investigate the concrete business operations. By effective data collection and performance evaluation, the companies can find its weakness and then make plans to improve their performance and competency gradually.

	Level 2	Level 3		
	Performance metrics	Complexity metrics	Structure metrics	Practices matrix
Plan	Planning cost Financial cost Inventory days of supply	Rate of order change Number of SKUs held Throughput Inventory holding cost	Products amount of different channels Number of channels Number of supply chain location	Planning period Forecast accuracy Obsolete stock on-hand
Source	Material acquisition cost Source cycle time Material acquisition time	Number of Suppliers Rate of source from long distance	Materials from long distance Rate of source from long distance	Supplier delivery performance Payment period Percentage of each purchased items by lead time
Make	Product defects or number of customer complaints Make cycle time Order fulfillment Product quality	Number of SKUs Flexibility with the increasing demand	Make process steps by area Utilization	Rate of value-added Rate of order fulfillment Inventory turnover Rate of change order by internal problems WIP
Deliver	Order fill rates Order management cost Order fulfillment lead times Rate of product return	Order numbers by channels Items and shipments by channel Rate of items return	Distribution location by area Number of Channels	Delivery lead time Percentage of invoices with wrong bill Methods of order entry

Table 6. Supply chain performance metrics and diagnosis metrics



5. Critical contents in strategic management level

5.1 Partnership maintaining

5.1.1 The types of enterprises relationship

The key to supply chain success is good relationship with partners and excellent collaboration in product design, manufacture and competitive strategy between them. What type relationship that the supply chain selected finally relies on the degree of knowledge reliance and information sharing between all the members of supply chain (General Administration of Quality Supervision, Inspection and Quarantine of PRC, 2001). Figure 7 shows the main five types of supply chain relationship. According to Figure7, contract and outsourcing is the basic types of collaboration. In these two types, the reliance is just accepted to a certain extent, and only a little information (of operations) is shared. Moreover, the relationships can exist just in a certain period.

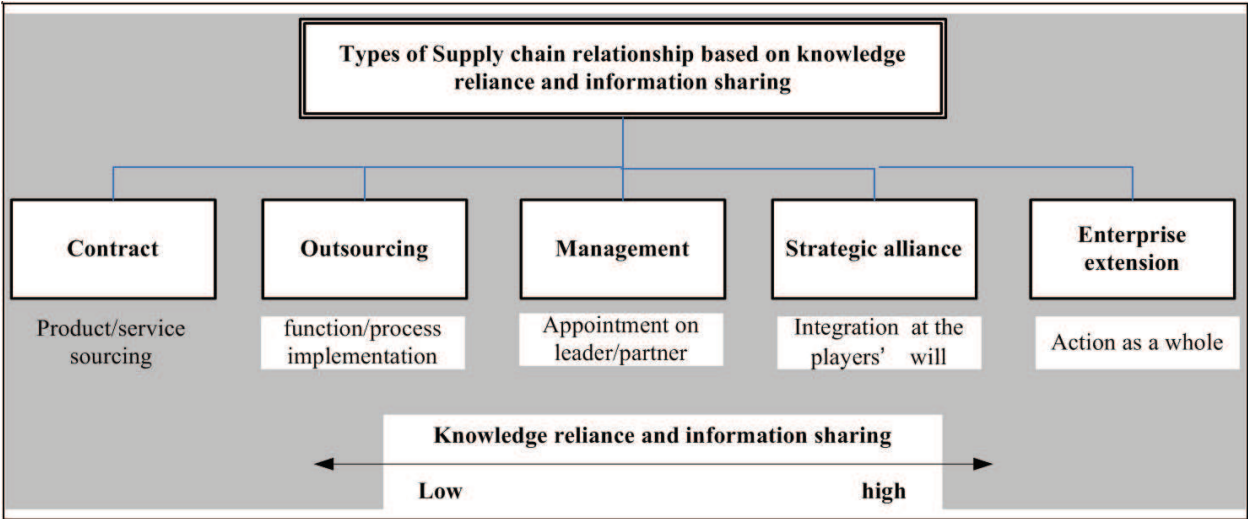


Fig. 7. The types of supply chain relationship

While with the management relationship, the focal firm usually takes the role of leadership and is in charge of looking for better collaboration with trade partners and service providers. Not only the operational information is shared, but some strategic information is shared as well. The relationships can last for a comparatively long time. Strategic alliance and enterprise extension are two types of partnership, with which the firms require collaboration and are willing to cooperate rationally in an integrated way. They reach consistency automatically to integrate human, finance, operations and techniques to provide greater customer value with higher efficiency. And an extended collaboration planning aiming at maintaining this relationship is included as well. Enterprise extension, which is across the border of single firm, is the end of knowledge reliance and information sharing. By total information and planning share, enterprise extension can increase the operational efficiency and enhance the relationship. Moreover, it presents a more simple way of CPFR which we have discussed in section 4.1.

5.1.2 Strategic partnership and the key to partnership maintaining

There is no doubt that Strategic partnership based collaboration can increase the cooperation and communication between functions and firms so as to balance production, synchronize logistics, at the same time, shorten the time to market of new product remarkably.

Furthermore, the partnership strengthens the flexibility and agility in the fierce market by a production mode of modularization, simplification and standardization oriented to high customization. Virtual manufacturing and dynamic alliance are typical forms of strategic partnership, which enhance the effect of outsourcing.

However, it is not easy to establish and maintain the relationship. The main reason is that all firms are always concern with their own benefits. So the depth and scope usually limited, even for the strategic partners. When the internal or external environments change, the firms may be suffer great disasters because their partners' mistakes or abandonment. Ericsson Corp. lost its competitive advantage in mobile phone market and declined generally from March 2000, when the Philip Co., a supplier of Ericsson, fired unexpected in a plant which resulted in a downtime in Ericsson for the lack of key components.

What firms can be chosen as the partners? In order to seamlessly cooperate, the partners should have consistent cultures, uniform strategic insights and inter-supported operational philosophy, which can ensure their core competencies are complementary to each other.

Then, how to maintain a long-term partnership? It relies on three aspects: common strategy and operational vision; bi-directional performance evaluation metrics, and the formal and informal feedback mechanism.

First, define the strategy and operational goals all together, and then trace, evaluate and update the goals often to achieve long-term improvements. For example, if the focal firm develops a new product, it should decide the common goals with its customers about the product market orientation. Also, the goals should take the retailers' key role in the process into consideration.

*Second, transfer the strategic and operational goals into detailed traceable performance measurements.* The focal firm and their partners should decide the metrics and measure frequency together. Meanwhile, the metrics should be bidirectional. Generally, the metrics between manufacture and their suppliers focus more on the suppliers' performance, for example, JIT delivery and quality. A research on strategic alliance developed a successful united metrics - total systematical inventory. The research point out that it is the inventory decrease of two sides that is really important to improve the whole supply chain performance, not only the inventory decrease of manufacturers.

*Third, evaluate performance, feedback and improve formally and informally.* Annually assessment is the most popular formal method, which is usually done by top managers aiming at checking and updating strategy goals. While quarterly check or monthly check are two kinds of informal method focusing more on tracing and evaluating the operational performance, which is usually top manager excluded. When informal checks implement, the alliance can change their operational practice to create good conditions for improve the planning and reach strategic goals. Weekly/daily checks are also informal activities, which are carried out by coordinators to solve routine problems and find the opportunities to improve. Although they are informal, they have a detailed mechanism to solve problems. In a word, they are vital for collision avoidance and are good for establishing close relationship between coordinators.

## 5.2 Cultural integration and cultural adaptation

Organizational culture is the common cultural values growing up with the development of an enterprise, which has been accepted by all the staff and workers, including the vision, the management philosophy, the tradition, the behavior regulation, the management system,

the relevant enterprise spirit, and so on. Generally, the culture will affect the behavior of firms and the culture consistency of supply chain, and then enhance the cohesion and competence of supply chain.

Cultural integration and adaptation is on the top of supply chain integration, which can be divided into integration within focal firm and adaptation between focal firm and their partners. Within the focal firm, the cultural integration should more strength the firm features, e.g. the values, the spirits, and the philosophy. And for the whole supply chain, the cultures should be adapted from the following three aspects.

*Strategies consistency*, the integration on the macro-level. The focal firm should confirm and enhance its core competence, while outsource the non-core competitive business by establishing strategic partnership with its supplier; on the basis, integrate the visions, competitive strategies and development tacit to reach their common goals.

*Philosophies or values adaptation*, the kernel and difficulty of cultural adaptation. The organizational philosophies and values, comprised of vision, philosophy, spirit, concepts of benefit, service, quality, etc., are the special standards on operational behaviors selection and evaluation shaping from its long-time operational process and the essential part of organizational culture. Values adaptation along the supply chain needs to separate the good from the bad, and then strengthen the good while delete the bad. Meanwhile, promote the values of focal firm and then form the common values accepted by all members generally.

*Management models integration*. In this operations level, different management models in supply chain should be analyzed to find, integrate and develop suitable spirits and souls for supply chain integration. By integrating management models, the improvement of employees' quality is linked with the improvement of supply chain competency, and a new incentive mechanism and supply chain culture that employees' fate is connected closely with the status of supply chain will be formed finally.

## 6. Conclusion

It is the good choice for a firm try to enter the global operation system to enlarge its market share and raise efficiency while its business develops strong enough. Generally, the process can be divided into three stages: international trade, branches establishment abroad and globalization. At the third stage, the firm can develop its business across the boundary in the international market. Therefore, it can improve the operational efficiency from three aspects at least: implement strategic supply of raw material and components; gain profit from low price labor by making and delivering in developing country; gain more profits from the tax preferential policy which makes the value-added model more attractive.

Up-to-date, most Chinese firms are still at the first stage. They are still relying on the low manufacturing cost from low price labor. However, just like the book *Supply chain management: the practices in Hong Kong Li & Fung Group* said: The production cost of a 4-yuan product in American market is only 1 Yuan. More important, it has almost reached the lowest and is difficult to decrease. So the firms must turn to the other 3 Yuan to make profits, i.e., make money by cost reduction in the whole supply chain processes, including product design, material supply, transportation, wholesaler and retailer, information and management. From the supply chain perspective, there are still lots of opportunities to decrease cost (Li & Fung Research Centre, 2003). ZARA and H&M have made good examples. Although no plant is established in China, they have entered Chinese market successfully with low cost and high profit through global supply chain integration. Chinese

firms should pay more attention on this trend and try to enhance the competitive advantage from supply chain advantage.

The paper explores a framework for supply chain integration, and explained the relative methods from three aspects- operational management, planning and controlling, and strategic management. By effective supply chain integration, Chinese firms will find a more competitive way to increase the capability of soft 3-Yuan and compete in world market.

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### **Supply Chain the Way to Flat Organisation**

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With the ever-increasing levels of volatility in demand and more and more turbulent market conditions, there is a growing acceptance that individual businesses can no longer compete as stand-alone entities but rather as supply chains. Supply chain management (SCM) has been both an emergent field of practice and an academic domain to help firms satisfy customer needs more responsively with improved quality, reduction cost and higher flexibility. This book discusses some of the latest development and findings addressing a number of key areas of aspect of supply chain management, including the application and development ICT and the RFID technique in SCM, SCM modeling and control, and number of emerging trends and issues.

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